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From Lab to Market

Scarcely a day goes by without some patented product of ARS research touching our lives. Orange juice from frozen concentrate, clothing tailored from drip-dry cotton or shrink-proof wool, shopping bags and containers strengthened with dialdehyde starch, and potato flakes for hurried homemakers, to cite only a few examples.

For the goal of ARS research, backed by legislative mandate, is to directly benefit the public. Thus ARS helps spur the march of agricultural technology by patenting its inventions and making them readily available. USDA, incidentally, promulgated a patent policy in 1905, the first federal department to do so. Getting an invention from an ARS laboratory to market is achieved in various ways, but most frequently by retaining patent rights and granting royalty-free licenses to all comers.

Utilization of ARS patents benefits not only farmers but all Americans. Finding a way to impart durable press properties into cotton textiles, for example, has created an annual market for 1.2 million bales of cotton that would have gone unsold. And tax revenues from the sale of citrus concentrate are greater each year than the total cost of research on that product.

Patents of public-service oriented agencies such as ARS are commercialized much more frequently—even without exclusive rights—than those of agencies that conduct research primarily for their own use. Moreover, public service agencies usually develop their inventions to a stage close to commercial application and often promote them to industry. Even so, many patents go unlicensed.

Industry often hesitates about adopting an invention that requires large amounts of venture capital for full commercial development, especially a high-risk and low-potential invention on a nonexclusive basis. Observers in and out of government suggest that such patents be licensed on an exclusive basis for a limited time. The recipient firm could then recoup its venture capital and, on expiration of its exclusive license, be able to face competition.

Whatever form patent policy of the future may take, the beneficiaries of agricultural research will ultimately be consumers, that means all of us.

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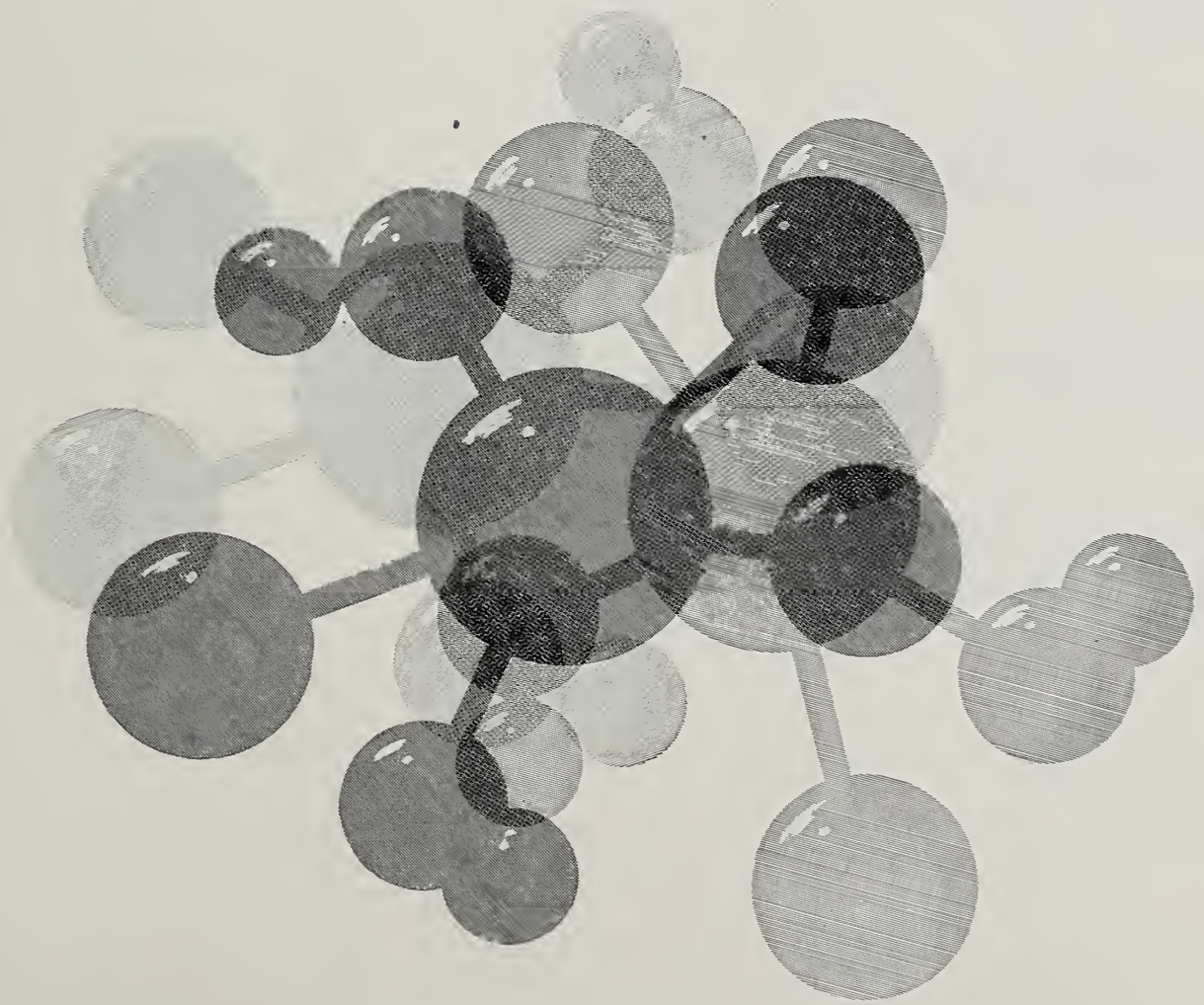
SHAPE OF SMELLS

ALARMED ANTS have provided important evidence supporting the theory that size and shape of molecules help determine how substances smell. And the story of the ants and the evidence is almost as involved as the theory itself, which is called the stereochemical theory of odor.

By 1965, entomologist M. S. Blum of the University of Georgia's Department of Entomology had collected an impressive amount of data on the alarm pheromone of the ant species *Iridomyrmex pruinosus*. Pheromones are natural substances emitted by insects that cause a typical reaction in other insects able to detect the substance.

Blum had found that the typical alarm response of the ants could be caused by several chemicals in addition to the natural pheromone, 2-heptanone. However, his data made it clear that there were limits to the range of active compounds.

Since there appeared to be a relationship between biological activity and molecular conformation, Blum contacted a scientist he knew to be a leading investigator of the stereochemical basis of odor and a prolific author of technical papers on the sub-



ject: ARS biochemist J. E. Amoore of the Western utilization research laboratory, Albany, Calif.

Amoore's investigations are primarily concerned with the relationship between molecular conformation and human olfactory response. But he recognized that Blum had excellent data for testing the stereochemical theory, so the two agreed to subject the data to stereochemical analytical methods previously used by Amoore and collaborators in Italy.

This analytical method employs photographs of the silhouettes of scale models of the chemical molecules.

To obtain these silhouette photographs, Amoore constructs models, positions them in specially designed camera equipment, and photographs them from three directions to get a set of silhouettes representing three dimensions of the molecule.

Amoore sends the silhouettes to the University of Genoa's Institute of Physics for examination by a unique pattern recognition machine, a hybrid instrument consisting basically of a modified television camera linked to a special computer. The machine was developed by electrical engineer G. Palmieri and in the ant pheromone study, was operated by his colleague E. Wanke.

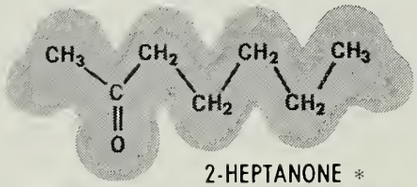
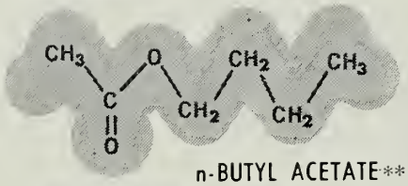
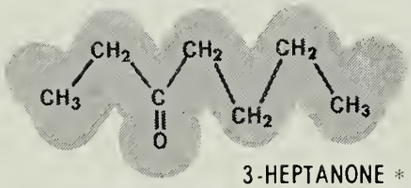
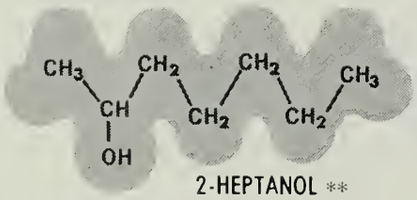
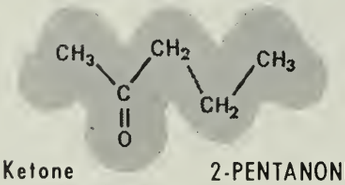
The machine is oriented for any given assignment by "training" it on the silhouette of a reference molecule (in this case the natural pheromone, 2-heptanone). When it is subsequently shown silhouettes of other molecules, it compares them with those of the reference molecule and prints out the degree of similarity within 5 seconds.

By prior agreement, Blum's data on the biological activities of the various chemicals were withheld from the ARS and University of Genoa scientists until the degree-of-similarity analyses were completed. Blum told only which chemicals he had used and his collaborators analyzed the molecular conformation data without knowing which had been active. Accordingly, biological activity and molecular conformation could not be correlated until the scientists felt they had enough data for a statistically sound experiment.

When, in April 1969, Blum's biological activity data were at last compared with the analyses of molecular shapes, highly significant correlations were immediately apparent. Substances with a remarkable range of chemical variation caused alarm activity, provided their molecular shape conformed closely to that of 2-heptanone.

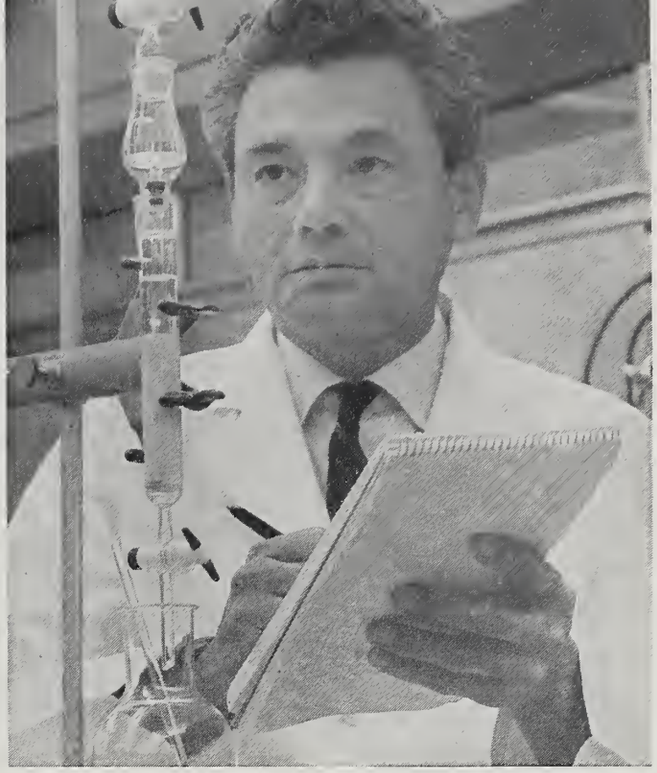
In addition to strengthening the stereochemical theory of odor, the results suggest the theory could be useful in explaining the activity of alarm pheromones of other species of ants and possibly other social insects.

The investigators stress, however, that their present methods may not be so successful when applied to certain highly selective insect pheromones, such as sex lures. Still more powerful computer procedures would have to be employed to explore these other possibilities.■

SILHOUETTE OF MOLECULE	DEGREE OF CONFORMITY	ALARM ACTIVITY
 2-HEPTANONE *	100%	5
 n-BUTYL ACETATE**	97%	5
 3-HEPTANONE *	76%	4
 2-HEPTANOL **	77%	3
 2-PENTANONE *	66%	2

* Ketone
** Non-ketone

At top is a silhouette of the molecular model of the natural alarm pheromone, 2-heptanone, which is a ketone. Other silhouettes represent four of the 84 other chemicals tested for alarm activity. One of the most active was a non-ketone, n-butyl acetate (PN–1834).



Velasco observes oil movement through equipment he designed. Reservoir at top feeds hexane into Velasco flask. Built-in tubing permits more accurate transfer of sample into tubing below, which contains the alumina column (ST–5491–25).

soybean oil test

do-it-yourself method for mills

COUNTRY ELEVATORS and oil mills can now determine on the spot the quality and quantity of oil obtainable from soybeans.

A new semiautomatic testing procedure has been developed by ARS chemist James Velasco at Beltsville, Md. Earlier tests of crude soybean oil involved procedures too sophisticated for application outside appropriately equipped laboratories, while shipping samples to a distant laboratory caused long delays.

The tests measure qualities affecting the price of soybeans, including oil color and the amount of refined oil to be obtained after processing. They also indicate the amount of free fatty acids; large amounts would mean the risk of rancidity developing in storage.

The test procedure involves passing the sample through a tube packed with alumina (aluminum oxide) that traps compounds normally separated in refining. In the first phase of the Beltsville studies, Velasco and his associates found that the alumina's standard moisture content—5 percent—was too low to completely trap the phospholipid portion of the crude oil sample. Final test results were consequently erroneous.

Velasco found that raising the alumina's moisture content to a range of 8 to 11 percent improved the procedure's trapping potential by 25 percent. Manufacturers quickly recognized this improvement and have incorporated Velasco's findings into commercial production of alumina.

Additional studies brought even more significant improvements to the oil test, moving it out of a restricted number of labs into practical application at field locations.

Velasco designed a new flask, for instance, which commercial glassware firms have already named after him. The Velasco flask virtually eliminates the risk of error in transferring a sample into the column of alumina. This error factor is critical because loss of even a drop of the 5-gram sample can affect results beyond the 1½-percent tolerance established for test errors. An error even this small can be costly in processing the many tons of soybeans the samples represent.

In using the test, the sample is first weighed in the Velasco flask, which is then attached to the tube of alumina. When ether solvent is added, the diluted oil sample automatically flows onto the alumina through a specially constructed siphon built into the flask.

At this point in the tests, Velasco solved another problem that prevented use of the test under typical hot field conditions: Laboratory experiments showed that he could successfully cap the alumina with a layer of hexane, whose chemical and physical properties sufficiently overcome heat and vapor pressure generated by interaction of solvent and alumina. This interaction formerly disrupted tests not conducted in controlled, aircooled surroundings—conditions that could not be met economically in the field.

In the final phases of the tests, solvent is evaporated from oil that has passed through the alumina. The purified oil is then compared with the original sample to calculate refining losses. Additional chromatographic tests may be made to evaluate color, stability, and other oil qualities.

In addition to soybean oil, the test may be used with cottonseed oil and perhaps other vegetable oils.■

...an ARS interview

the MOON

SCIENCE FICTION FANS may have been disappointed, but biologists took in stride the evidence that no living things showed up in soil and rock moon samples.

That's the observation of ARS microbiologist J. D. Menzies, a member of the lunar sample Preliminary Examination Team at the Lunar Receiving Laboratory of the National Aeronautics and Space Administration, Houston, Tex. Menzies, who served during both the Apollo 11 and 12 moon shots, does research at the U.S. Soils Laboratory, Beltsville, Md.

AGRICULTURAL RESEARCH recently had the opportunity to ask the ARS researcher a few questions of its own—not unlike many of the questions put to him since his return from Houston.

What questions are you most asked by persons without a scientific background? And what are your answers?

Most laymen ask if any substance useful to earth was found on the moon. The answer has to be no. The gold and diamonds of science fiction and the comics were not detected.

Another frequent question is "Will

"Most biologists accept without surprise that we found no evidence of living things, . . ." (1169D171–12).

ROCKS

the moon soil grow plants?" Two unique features of the moon provide the answer. Without an atmosphere containing nitrogen, there is no way for this essential element to occur in moon soil. And without water, wind or microbes, there are no weathering processes whereby raw rock is converted into a soil capable of nourishing plant growth. The moon soil is apparently not toxic and would permit plant growth if used in an earth environment and amended with the essential nutrient solution.

What is the question most asked by your fellow scientists not connected with the moon samples?

Most biologists accept without surprise that we found no evidence of living things in the moon samples and are more interested in the question of whether there could have been ancient life or prelife organic substances. All the tests reported so far show that if there is any organic carbon in the samples, it is below the level of detection—less than 1 part per million. There is no evidence that free water has ever been present. Studies of the moon may help us understand the origin of the earth but are not likely to help in unraveling the origin of life.

How were the samples checked for living organisms by microbiologists?

The life detection tests were quite comprehensive and were conducted by many trained investigators in special laboratories. Samples were examined by all kinds of microscopic techniques looking for direct evidence of anything resembling a known micro-organism. Other samples were cultured on a wide variety of culture media under different incubation conditions. In addition, a great many earth life forms were inoculated with moon material to test for any pathogenic or toxic reactions. Some 30 different plant species representing the major food crops of the world were exposed either as sterile seedlings, germinating seeds, or tissue cultures. Among animal forms inoculated were germ-free mice, several mammalian tissue culture lines, Japanese quail, protozoa, planaria, three species of insects, shrimps, oysters, and fish. At the end of the 6-week test period, none of the tests gave any evidence of any pathogenic agent in the moon samples, nor even any evidence of life.

Are you afraid of failing to detect extra-terrestrial organisms?

We must recognize that any short-term quarantine test would expose only a very small fraction of earth's life forms to the hazard under very special conditions. Negative results would be far from conclusive. This, however, does not mean we should fail to take reasonable precautions. The only real danger, theoretically, would be that some form of extra-terrestrial life could grow explosively on earth and be pathogenic or harmful to earth life. Our real protection is (1) the overwhelming evidence against extra-terrestrial life in our solar system; (2) the unlikelihood that an organism adapted to the environment of another planet could even survive on earth; and (3) if it did survive, the even more remote possibility that it would possess pathogenic capabilities. To me, the presumably safe things we do every day in experimentally modifying earth life or earth environments are much more hazardous than life from outer space.■

Above: *Technician Paula Peters collects tape covered with eggs laid by female cabbageworm butterflies. Tape was attached to containers with leaf lids from host plant, mustard (1069Z46–22).* ***Below:*** *Wasps are reared by putting them into cups of about 75 cabbageworm larvae. Wasps lay eggs in larvae and are removed after 24 hours. Cups are sealed for 10 days incubation. When parasites exit from larvae, the larvae die, and the parasites spin cocoons (1069Z46–13).*

Cover: *Parker observes parasites before releasing them in the field (1069Z44–5).* ***Below:*** *Parasite cocoons are transferred to rearing cage. After 6 days, they emerge as wasps and are released in test fields (1069Z46–11).*

BUILD UP

CABBAGE and other cole crops may be protected from imported cabbageworms by rearing and releasing *both* the pests and their biological enemies.

This novel approach to pest control has given encouraging results with two species of parasitic wasps at the ARS entomology laboratory, Columbia, Mo. In a series of 1-acre field tests, entomologist F. D. Parker controlled 92 to 99 percent of the cabbageworms.

In one phase of the tests, Parker released *Trichogramma evanescens*, an insect parasite scarcely visible to the naked eye and harmless to humans. Its mode of attack is to lay eggs in the eggs of imported cabbageworms. When grubs of *Trichogramma* hatch, they devour the host eggs. The

Top left: A. rubecula *wasps are released in cabbage plot at the rate of 3 to 5 thousand per acre (1069Z44–27).* ***Bottom left:*** *Wasp lays eggs in cabbageworm (1069Z47–12).* ***Above:*** *Parker records population estimates and specimens of pests and predators in untreated field (1069Z45–21).*

THE ENEMY - then knock him down

wasp lays about two eggs per host egg and produces three generations to each one of the cabbageworm.

Unfortunately for growers, development of a large number of these wasps in nature requires a large pest population to provide eggs for the parasites to feed on. Consequently, heavy crop damage would occur before the parasites become sufficiently numerous to overwhelm their hosts.

Parker overcame this natural lag by providing the wasps a large number of eggs for them to parasitize at the beginning of the growing season. In one test, he made three releases, 3 weeks apart, of a total of 74,712 fertile cabbageworm butterflies in a cabbage field. The butterflies laid more than the 10,000 eggs actually counted on the cabbage seedlings, providing ample food for the parasites. In coordination with the first and third releases of butterflies, Parker released a total of 1,306,000 *T. evanescens* wasps.

Parker kept up the biological pressure on cabbageworms that emerged from unparasitized eggs by releasing 8,200 of a similar parasitic insect, *Apanteles rubecula,* which is also harmless to humans. *A. rubecula* complements the habits of the first parasite by seeking out caterpillars in which to lay its eggs at a time when temperatures normally reduce the activity of *T. evanescens.*

By the third generation of cabbageworms, usually numerous enough to destroy crops, only 18 of the pests per 100 plants survived parasitization—which represents 99 percent control. Parker noted that other predatory insects, such as lady-bird beetles, provided additional biological pressure, but the wasps represented the main line of attack.

The wasps were effective in seven other smaller field tests; tests are now continuing on a larger scale to determine the effects of different environmental conditions, release methods, and related operations.

This technique may also help control other insect pests. The parasites will be tested in Texas against two species of *Heliothis* moths that infest corn, tomatoes, cotton, and tobacco. Host insects will not be released to give parasites a head start on the native *Heliothis;* instead, the entomologists will provide wasps with eggs of the Angoumois grain moth, which is harmless to growing crops.■

the cabbageworm

slow road to successful control

THE SUCCESSFUL PERFORMANCE of *Trichogramma* and *Apanteles* wasps against imported cabbageworms may prompt the question, "Why didn't anyone think of it before?"

Scientists have, in fact, been testing *Trichogramma* in biological control experiments for about 70 years—unfortunately, with discouraging results. The Columbia laboratory's good results are owed in large measure to research by a team of ARS entomologists led by F. R. Lawson. In their experiments, the entomologists integrated for the first time information they had obtained about the parasites, their hosts, and environmental factors.

Although further research is needed, the entomologists have already found that some species of the parasites are more suited than others to various hosts and environments. In basic studies of one of the most promising species, *Trichogramma evanescens*, for example, entomologist N. L. Marston at Columbia, Mo., found that it searches more efficiently for the eggs of the imported cabbageworm than the American species, *T. minutum*. *T. evanescens* was acquired in Europe 3 years ago by ARS entomologist J. R. Coulson, then stationed in Paris.

At Columbia, entomologist R. K. Morrison has established laboratory colonies of about 10 species of *Trichogramma*—more than were known to entomologists 70 years ago. And the laboratory is geared to producing millions of the parasites weekly—another resource not available to earlier researchers.

Laboratory colonies are maintained on eggs of the Angoumois grain moth, which Morrison found is cheaper and easier to rear in the laboratory than the natural host. The mass-rearing system developed by Morrison produces up to 10 million host eggs daily, and production can be easily increased. The present host-parasite production system provides about 1 million *Trichogramma* daily, at a cost of only $3.

The entomologists added more zing to the biological control experiment by releasing *Apanteles* wasps, which attack larvae that escaped parasitization in the egg stage by *Trichogramma*. ARS entomologist F. D. Parker found that a European species, *A. rubecula*, provided greater control than its cousin, *A. glomeratus*, which was introduced 70 years ago.

Laboratory studies showed that cabbageworms have little or no immunity to *A. rubecula*, in contrast to *A. glomeratus*. The pests encapsulate eggs of *A. glomeratus* by surrounding them with a tissue barrier in which eggs of the parasite cannot develop and hatch.

In related basic studies, entomologist K. D. Biever found that behavior of the two European species is complementary: *T. evanescens* parasitizes eggs more actively at temperatures in the mid-80's. By contrast, *A. rubecula* parasitizes larvae most actively at temperatures in the low 70's.

Happily, the pests' egg-laying and larval-feeding activities correspond closely to the same temperatures affecting the parasites' activities. This favorable coordination of host-parasite biology plays an important role, because environmental conditions that might stimulate the host and inactivate the parasite could doom the potential for biological control.■

The Apanteles rubecula *wasp is released in test fields only if other parasites cannot control the egg population because of adverse weather conditions such as cold or rain (1069Z44–26).*

Cooley and technician Kenneth Mueller observe evaporation reduction efficiency of lightweight concrete blocks (1069Z48–2).

FLOATING CONCRETE

one way to block pond evaporation

Floating concrete blocks are among several lightweight materials that can cut evaporation losses in stock tanks and small ponds during hot weather.

These floating blocks aren't made of the freeway type of concrete but a mixture containing perlite ore as a lightweight aggregate instead of sand and gravel. The blocks are cast into tiles 7 by 11 inches and 1½ inches thick. In tests, blocks covering 80 percent of the water surface reduced evaporation by 60 percent.

Reducing evaporation loss can save farmers and ranchers time and money. Hauling costs per 100 gallons of water start at about $4—sometimes nearer $10—while evaporation control may cost less than $1.50 per 100 gallons.

ARS meteorologist K. R. Cooley at the U.S. Water Conservation Laboratory in Phoenix, Ariz., also tested wax, perlite, styrofoam, butyl rubber, and other lightweight materials. He finds wax the most feasible right now. Wax cut evaporation 100 percent for the area covered.

Cooley says wax is easier to handle than most of the other materials, including the concrete blocks. It is applied by squirting molten wax through a nozzle directly onto the water. The wax forms circles 6 to 8 inches in diameter and about 1½ inches thick.

Although one wax tested had a tendency to melt on very hot days, a new wax with a melting point at about 130° F. should not cause similar problems under hot conditions.

Another way to curb evaporation losses is by sprinkling loose perlite directly from bags onto the surface of the water. On one 53- by 78-foot pond in Arizona, the perlite cut evaporation 20 percent during an 8-month study. Perlite, like other loose materials, has a tendency to stack up on the lee side of a pond when wind velocities are brisk; however, it redistributes when the wind recedes.

No appreciable reduction in the size or number of fish was noted in ponds during these studies, and livestock did not appear to be bothered by any of the materials.

Along with saving water, the materials reduced weeds and algae in ponds by cutting off sunlight and inducing cooler temperatures.■

Geneticist J. W. Smith examines a milking machine that can milk each teat of experimental cows separately and collect the milk in separate containers (ST–328–22).

dip after milking

to prevent udder infections

CHEMICALLY SANITIZING cows' teats immediately after milking is a promising way to reduce the incidence of udder infections that cause mastitis.

A number of micro-organisms infect the udder, contributing to the general inflammation called mastitis. Bacterial invasion likely begins with a beachhead at the openings of the teats, for colonies of bacteria there are dangerously close to the udder's interior. Now, research at Beltsville, Md., and Ames, Iowa, indicates that the best time to apply control measures is immediately *after* milking, not before, as is usually done.

At Beltsville

ARS microbiologist W. D. Schultze selected, from cows in a regular milking barn, a group with large skin populations of staphylococcus bacteria on their teats. Immediately after these cows were milked, half of the group's teats were dipped in a solution containing the disinfectant chlorhexidine at 2,000 parts per million.

Thirty days of dipping reduced the average staph level on teat ends from 84 points to 3 points on a scale where 100 represents a heavy infection. Population scores of cows with untreated teats did not change in the same month.

To doublecheck, Schultze switched the use of the dip to the other half of the cow group. Dipping lowered the average skin population score from 84 points to 4 points, while the score of the formerly treated cows rose from 3 to 57 points in 21 days.

As a direct test, Schultze then isolated a smaller group of cows and deliberately exposed them by dipping teat cups of the milking machine in rinsing water laden with about 5 million staphylococcus per milliliter. One side of each udder was dipped in the sanitizing solution after each milking; the other side remained untreated. Since each udder quarter is an independent gland without direct connection to the other three, one quarter can become infected while the others remain healthy.

Fourteen percent of the dipped quarters became infected, while 41 percent of the unprotected quarters caught mastitis during a year's lactation.

The dip used by Schultze contained an agent to prevent chapping of the teat skin, a side-effect that may become serious with lengthy dipping. Schultze first used tung oil, a drying agent incorporated in at least one commercial teat dip as a chapping preventive. Some cows still suffered from extensive skin scaling and irritation.

He then tried lanolin, a softening agent often used in cosmetic lotions for humans. This base prevented skin problems throughout the year in all but one test cow, but no dip that contains lanolin is commercially available, so far as Schultze knows.

At Ames

Veterinarian J. S. McDonald exposed the teats of noninfected dairy cows for three weeks to teat cups dipped in milk contaminated with 2 million *Streptococcus aureus* bacteria per milliliter. Udder infection was prevented by dipping teats in chlorhexidine solution within 30 minutes after milking with contaminated equipment.

McDonald then dipped teats directly in bacterial cultures and continued dipping teat cups in contaminated milk for another 3 weeks. Dipping in the disinfectant still prevented udder infection. Only when McDonald added another stress—overmilking for 4 minutes just before contaminating teat and teat cups—did 1 percent of the udder quarters become infected. The tests were conducted at the National Animal Disease Laboratory.

Dipping teats in disinfectant solution must be done after milking. McDonald sanitized teat cups before milking each cow, but contaminated teat ends immediately after milking. A half hour before the next milking, he dipped teats in disinfectant, yet 2 percent of the quarters became infected during the 3-week trial.

Dipping really was the difference in preventing udder infection. McDonald cured all udder infections that had occurred during previous trials, then dipped all teats before and after each milking for 3 weeks. Teat cups were also dipped in infected milk. Without treatment, more than 9 percent of the quarters of cows on trial became infected.

The dip tested by McDonald was unusual in that its chlorhexidine strength was five times that of common commercial dips—10,000 p.p.m. instead of 2,000 p.p.m. McDonald strongly recommends the high strength. At least one commercial dip with 10,000 p.p.m. chlorhexidine is already marketed; cost is about one-quarter cent per cow per milking.■

MAREK'S DISEASE

Turkey virus research may lead to vaccine

A NEWLY ISOLATED VIRUS from turkeys shows promise for the control of Marek's disease, which costs the poultry industry about $200 million annually.

Discovered in research led by ARS veterinarian R. L. Witter, East Lansing, Mich., the turkey virus causes the chicken's body to produce antibodies similar to those formed in chickens infected with the herpes virus that causes Marek's disease. So far, the turkey virus has not caused disease in chickens or turkeys. Tests have shown that chickens inoculated with the nonpathogenic virus were protected against attacks by the Marek's disease virus.

Marek's disease is extremely contagious and produces a high rate of mortality in a short time. At present, there is no preventive or combative treatment. Sanitation (AGR. RES., Dec. 1966, p. 5) has been recommended but, unfortunately, does not assure that Marek's disease will not occur in a new replacement flock.

The causative herpes virus was only recently discovered (AGR. RES., Oct. 1967, p. 6). Formerly, Marek's disease had been grouped with avian lymphoid leukosis, a disease it closely resembles. These two diseases are still easily confused since the clinical signs are very similar. Marek's disease, however, strikes swiftly and takes a high toll, while lymphoid leukosis is a chronic affliction with a low mortality rate. Also, Marek's disease does most of its damage to young broilers and layers, while lymphoid leukosis hits chickens after sexual maturity.

Further investigations will be conducted to determine whether the turkey virus is safe and effective as a vaccine that will confer immunity against Marek's disease. This may require a long time. Laboratory studies and field trials must be carefully planned and conducted to insure proper evaluation of the turkey virus. But the outlook is promising.

The turkey virus may also help scientists to better understand the interrelationship of tumors and viruses in other animals and man. Related but different viruses are associated with many diseases of man and animals and have been isolated from human lymphoid tumors.■

waste brush helps grass grow

ARID RANGELANDS depleted by years of periodic drought, overgrazing, and brush invasion may be restored to productivity with a new regrassing technique.

ARS range scientist C. H. Herbel has achieved remarkable success in establishing grass seedlings in southern New Mexico by using a mulch of uprooted range brush to conserve available moisture and reduce soil surface temperatures.

Upwards of 80 million acres in the Southwest lack adequate range grass. Cattlemen are hard pressed to provide sufficient forage for their cattle, and conservationists are plagued with serious water and wind erosion problems.

Good stands of range grasses would solve most of the problems, but seeding and establishing the plants is difficult because of the hot, dry periods during the summer growing season. Excessively high temperatures of soil surfaces cause rapid evaporation of what water is available so that seeds fail to germinate or seedlings die from lack of moisture. And most seeding methods leave the ground surface bare and exposed to direct, intense solar radiation.

Moreover, rainfall is usually erratic, poorly distributed, and often occurs as high intensity thunderstorms, causing rapid runoff with accompanying flash floods, excessive soil erosion, and soil crusting. Seeds may be washed away or prevented from emerging by the soil crust.

In studies at the Jornada Experimental Range near Las Cruces, N. Mex., Herbel tested the effects of various moisture and temperature regimes on the development and growth of several range grasses. The test area was typical of arid, semi-desert grasslands. His experiments showed that black grama, sideoats grama, various lovegrasses, and fourwing saltbrush would grow well despite the severe conditions, provided a mulch was used to lower soil surface temperatures and to retain moisture during the plants' critical developing period.

Most systems using artificial mulches—such as straw, cotton gauze, or plastic film—are too expensive for anything but lawns, roadsides, waterways, and other high-value areas. But Herbel's method is inexpensive and practical. In field trials he applied a mulch of readily-available natural range brush over seeded areas. The mulch reduced daily maximum soil temperatures from as high as 148° F. to 108° F., and held moisture in the surface soil up to eight times as long as unshaded soil. It also absorbed the force of the rain, allowing it to seep gently into the ground.

A machine developed by engineer G. H. Abernathy of the New Mexico Agricultural Experiment Station plays a key role in Herbel's system. Towed by a tractor, the wagon-like apparatus accomplishes all the work in a single pass over the ground. It uproots the brush, levels the soil, sows and covers the seed with soil, scoops shallow basins which become miniature reservoirs to slow runoff, and finally drops the brush in a windrow to form a protective canopy over the seeds.

The rig is crude, Herbel admits, but the equipment can be refined later. The main thing, he says, is that the system works and grows grass.

After the new grasses are well established—usually a full growing season—cattle can be grazed in the area under carefully controlled management while other areas are being seeded and developed.

The system shows that grass can be effectively and economically established on what now is almost barren ground. Once established and well-managed, the grasses will flourish. And land that now requires 600 acres or more to support a single range animal will increase in forage capability 5 to 10 times. Furthermore, grassland restoration would reduce erosion problems and the land would gain wider usefulness and become more acceptable for habitation. ■

The tractor-towed apparatus plants and protects seed in a single pass over rough range (BN–34163).

oats that escape rust

CROWN RUST has been keeping plant geneticists on a research treadmill for the past 50 years. This disease, caused by a parasitic fungus, produces reddish-orange spots and discolorations on oat plants resulting in losses of about $19.5 million annually.

Crop scientists are engaged in a continuing research effort to minimize these losses by developing resistant oat varieties. And this is where the treadmill begins rolling. Within 3 to 5 years after a new resistant variety becomes widely grown, a different strain of rust develops and overcomes the new variety's resistance. Scientists must then develop still another resistant variety.

This cycle prevents oat research programs from achieving their fullest potential, says ARS plant geneticist H.H. Luke in Gainesville, Florida. Time consumed in developing resistant varieties is delaying more concerted efforts to breed varieties that are of higher quality and that produce higher yields.

How, then, can the rust problem be resolved? Luke feels that the answer may lie in such late-rusting oat varieties as Red Rust Proof 14 and Appler. These varieties do not become susceptible to rust until late in the growing season, and they are relatively immune up to that time.

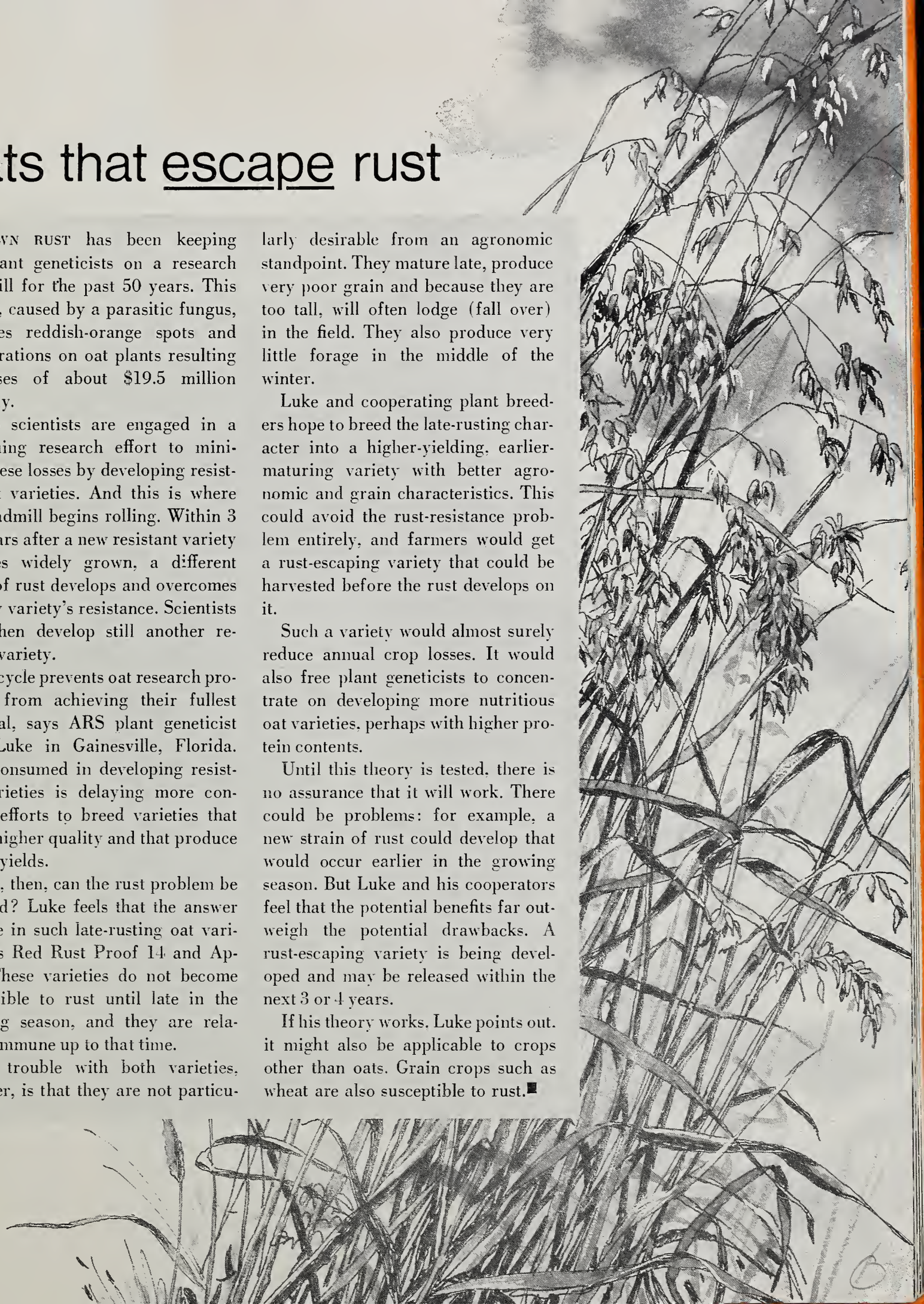
The trouble with both varieties, however, is that they are not particularly desirable from an agronomic standpoint. They mature late, produce very poor grain and because they are too tall, will often lodge (fall over) in the field. They also produce very little forage in the middle of the winter.

Luke and cooperating plant breeders hope to breed the late-rusting character into a higher-yielding, earlier-maturing variety with better agronomic and grain characteristics. This could avoid the rust-resistance problem entirely, and farmers would get a rust-escaping variety that could be harvested before the rust develops on it.

Such a variety would almost surely reduce annual crop losses. It would also free plant geneticists to concentrate on developing more nutritious oat varieties, perhaps with higher protein contents.

Until this theory is tested, there is no assurance that it will work. There could be problems: for example, a new strain of rust could develop that would occur earlier in the growing season. But Luke and his cooperators feel that the potential benefits far outweigh the potential drawbacks. A rust-escaping variety is being developed and may be released within the next 3 or 4 years.

If his theory works, Luke points out, it might also be applicable to crops other than oats. Grain crops such as wheat are also susceptible to rust.■



AGRISEARCH NOTES

Foam Protects Crops

Foam is being studied as a means to protect vegetable crops against untimely freezes in the Lower Rio Grande Valley of Texas.

ARS soil scientist J. F. Bartholic, agricultural engineer R. J. Rektorik, and soil scientist M. D. Heilman, Weslaco, Texas, tried a firefighting type foam on two plots of bell peppers instrumented with a number of temperature sensors.

Results of the tests showed that leaf temperatures during the coldest part of the night were 3° to 5° F. warmer in plants under the foam than nonfoamed plants. Temperature at the 1-inch soil depth remained constant after foaming but continued to drop in the nontreated plot.

The information backed up the theory that the soil contains enough heat to sustain the crop if adequate insulation is provided.

The study will continue in search of a foam with greater stability and a generator with a capacity large enough for field-size operations.

Breaking Pearl Millet Dormancy

A newly developed method for breaking dormancy in pearl millet seed is a boon to plant breeders.

Pearl millet seed often is completely dormant for several weeks after harvest. Normally this is no problem, but in plant breeding programs designed to grow three or more generations a year, dormancy has been a major obstacle.

ARS geneticist G. W. Burton at Tifton, Ga., found that dormancy of freshly harvested pearl millet seed could be readily broken by soaking seed for 1 hour in a water solution containing 1 percent 2-chloroethanol and 0.5 percent sodium hypochlorite. The treatment broke the dormancy of many pearl millet seeds that failed to germinate without it.

Burton also obtained improved germination of partially dormant seed with 1-hour water soaks containing other compounds. In descending order of efficiency, they were 2-chloroethanol, hydrogen peroxide, sodium hypochlorite, potassium nitrate, sulfuric acid, potassium salt of gibberellic acid, and kinetin.

Filtered Air for Healthy Poultry

Respiratory diseases of poultry, caused by airborne micro-organisms, appear to be prevented by filtering incoming air and maintaining a higher air pressure inside the poultry houses than outside.

In 3 years, 10 laying flocks that were hatched, reared, and maintained in five filtered-air, positive-pressure houses (FAPP) at the Southeast Poultry Research Laboratory, Athens, Ga., have shown no signs or serological evidence of avian respiratory diseases. Also, flocks maintained in conventional houses nearby are infected with Marek's disease, while those in the FAPP houses have apparently remained free of the disease.

In the new system, FAPP equipment filters and cools or heats incoming air. The ventilation blower runs constantly, forcing the filtered air into the practically airtight building, then out through the exhaust ports. The greater air pressure inside the house prevents unfiltered air from entering.

Before starting a new flock, the house is thoroughly cleaned and fumigated. Eggs that have been incubated for 18 days are transferred to a hatcher within the FAPP house and fumigated with formaldehyde prior to hatching. The caretaker is required to use clothing and boots that are restricted to that house, and to use a disinfectant foot bath when entering or leaving the house.

The system could be incorporated into the design of new poultry houses or added to existing houses. Once properly installed, it would not require specially trained poultry workers for operation. The system, however, has not yet been field-tested.

CAUTION: In using pesticides discussed in this publication, follow directions and heed precautions on pesticide labels. Be particularly careful where there is danger to wildlife or possible contamination of water supplies.

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